Missouri Department of Natural Resources
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Preparing Solid Waste Disposal Area Closure and Post-Closure Plans

Solid Waste Management Program technical bulletin 4/2004

Introduction

The Missouri Department of Natural Resource's Solid Waste Management Program has developed this technical bulletin to help landfill owners prepare closure and post-closure plans. Closure and post-closure plans are intended to describe how a facility will be closed and maintained, and more importantly to provide a basis for calculating the amount of financial assurance required for the facility. Closure and post-closure plans must be prepared or approved by a Professional Engineer (P.E.) registered in the State of Missouri, and must be approved by the Solid Waste Management Program.

The Missouri Solid Waste Management Regulations contain the following requirements in regard to closure and post-closure plans:

- Owners of active sanitary landfills are required to provide closure plans and thirty-year post-closure plans.
- Owners of active demolition landfills, utility waste landfills and special waste landfills are required to provide closure plans.
- Owners of demolition landfills permitted after July 30, 1997, are also required to provide thirty-year post-closure plans.
- Owners of utility and special waste landfills permitted after July 30, 1997, are required to provide twenty-year post-closure plans.
- Owners of inactive landfills are required to provide closure and post-closure plans in accordance with the regulations in place at the time the facility ceased accepting waste.

This technical bulletin addresses two aspects of closure and post-closure plans: the text of the plan itself and the closure and post-closure cost estimates. These aspects apply to the following facilities:

Text of the plan
- Applies to facilities permitted after the date of this technical bulletin.
- Currently active facilities and permitted facilities that are not yet constructed will only be required to revise the text of their closure and post-closure plans to follow this new format when updating their closure and post-closure plans for any reason.
- Does not apply to inactive facilities (those that have ceased accepting waste).

PUB000195

Cost estimates

- Applies to facilities permitted after the date of this technical bulletin.
- Currently active facilities, and facilities that are permitted but not yet constructed will be required to revise their cost estimates with the next annual financial assurance update.
- Does not apply to inactive facilities.

The Solid Waste Management Program recommends that the closure and post-closure plans be a separate document rather than a section, or appendix, of the overall engineering report for the facility. It is important to make a distinction between the closure and post-closure plans and other aspects of the engineering design. The regulatory requirements are specific for final cover systems, gas control systems, surface water control systems, and environmental monitoring systems. The detailed aspects of design should be addressed in the appropriate section of the engineering report. The closure and post-closure plans address more general requirements.

Where possible, the closure and post-closure plans should refer to the approved design and the approved monitoring plans, but should not reiterate them in detail. Nor should changes to the closure and post-closure plans be submitted to modify the design of the final cover system, the surface water control system, the gas collection system, the gas-monitoring plan, or the groundwater monitoring plan. The closure and post-closure plan should focus on implementation of the design, the monitoring plans, and the maintenance activities**.**

Not only will eliminating redundancy decrease the chances for contradictions between the engineering design documents and the closure and post-closure plans, but in many cases it will allow the owner to modify some aspect of the design, or perhaps a monitoring plan, without having to make changes to the closure or post-closure plans.

This technical bulletin has been written to address the most detailed aspects of closure and post-closure. Many of the design features discussed here, such as geosynthetic caps and active gas collection systems, may not apply to demolition landfills, utility waste landfills, special waste landfills, or older areas of sanitary landfills. Only those portions applicable to the design and operation of your facility must be addressed.

Closure Plan

According to the regulations, closure plans must include a description of the methods and time schedules for closure of the permitted area. The plans may have distinctly different contents for older facilities as opposed to newer ones.

Methods

The engineering design should already address in detail the construction methods to be used for the final cap system and other systems that will be built during closure, such as the gas control system and the surface water control system. There is no need to repeat these construction methods in detail in the closure plan. However, the quality assurance/quality control (QA/QC) methods for these systems may not be clearly specified in the approved engineering design. QA/QC is an important part of closure since it forms the basis for the engineering certification that the facility was properly closed. It includes things such as laboratory and field testing of soils and membranes as well as survey control. It is essential to address this aspect of construction in one way or another. While more modern facilities usually have separate QA/QC plans, older facilities may not. If not, this aspect of closure must be addressed in the closure plan.

Schedule

Since the closure schedule depends on unpredictable factors, particularly waste flow, it would be futile to present a detailed closure schedule in the closure plan. This aspect of closure would more appropriately be termed a closure sequence. Again, for older facilities as opposed to newer ones, the closure plan may have a different focus in this regard.

Newer facilities are typically designed in phases. Current regulations require landfill owners to submit phase development drawings to show how the site will be developed. These drawings should be detailed enough to show the various stages of development of the landfill, from liner construction in new phases through closure of older phases, including construction of gas and surface water control systems. In other words, the closure sequence should already be laid out in sufficient detail in these phase development drawings. However, for older facilities, phase development drawings more than likely do not exist and should be included in the closure post-closure plan.

The closure plan must address the following:

- The plan must indicate the closure status of all areas within the permitted boundary that have received waste, regardless of when they were filled.
- The plan must indicate whether the facility will close in phases or all at one time.
- The plan must indicate the total size of the entire landfill footprint.
- For phased closure, the plan must also indicate the size of each phase.
- The plan must indicate that Missouri Department of Natural Resources will be notified in writing at least 180 days before the anticipated last receipt of waste in the landfill; or, for phased development, in any particular phase.
- The plan must indicate that closure will begin within 30 days of the last receipt of waste in the landfill or phase and will be completed within 180 days of beginning closure. The regulations allow the department to grant extensions to these time frames in certain situations, but any proposed deviations must be clearly indicated in the closure plan.
- The plan must indicate all the major steps necessary to close the landfill based on the approved engineering design and the conditions of the permit.
- For phased facilities with approved phase development drawings, the closure sequence should be summarized in the closure plan in enough detail to allow the department to determine when various landfill components will be constructed.
- For phased facilities without approved phase development drawings, the closure plan should include drawings clearly showing the planned closure sequence for the facility. The drawings should be correlated with the text of the plan to clearly indicate when various landfill components will be constructed.
- If you have an approved QA/QC plan for your facility that addresses the current regulatory requirements and construction verification procedures for the final cover system and other components to be installed or constructed as a part of closure, a simple reference to the QA/QC plan in the closure plan is sufficient.
- If you do not have an approved QA/QC plan, the closure plan must include a QA/QC plan for the final cover system and any component that will be installed as a part of closure. The QA/QC plan must address all field and laboratory procedures that will be used to verify the material properties and the construction methods for each component. The QA/QC plan must also address survey control.
- The plan must indicate that, upon completion of closure activities, a P.E. registered in the state of Missouri will certify that the facility or phase was properly closed.

Post-closure plans

According to the regulations, post-closure plans must address the maintenance and monitoring activities required during the post-closure period. However, most of the monitoring activities are performed in accordance with approved surface water, groundwater, and gas monitoring plans. There is no need to reiterate these monitoring plans in great detail in the post-closure plan. A simple reference is adequate. The plan should focus mostly on maintenance activities.

The post-closure plan must address the following:

- The plan must show that groundwater monitoring and gas monitoring will be done in accordance with the approved monitoring plans and the terms and conditions of the permit.
- The plan must show that surface water monitoring, if applicable, will be conducted in accordance with the terms and conditions of any permit(s) issued by the Missouri Clean Water Commission.
- The plan must show the activities necessary to maintain the integrity of the final cover system, the leachate collection system, the gas control system, the gas monitoring system, the surface water control system, the groundwater monitoring system, and any other system specified in the approved engineering design.
- The plan must show the location where landfill records will be kept during the post-closure period. A copy of these records must be made available to the appropriate department staff upon request.

Financial assurance and cost estimates

Current regulations require owners of sanitary, demolition, and utility waste landfills to provide a closure Financial Assurance Instrument (FAI). Sanitary landfill owners are also required to provide a post-closure FAI. FAIs are necessary to ensure that the department has sufficient funds to properly close and maintain the facility in the event the owner is unable to do so. The closure FAI may be returned if final closure has been approved in writing by the department. A portion of the post-closure FAI may be returned annually starting on the sixth anniversary of the beginning of the post-closure period, and the remainder may be refunded after completion of the post-closure period.

New facilities

The solid waste disposal area permitting process is separated into several distinct steps. In addition to the preliminary and detailed site investigation requirements, owners of new facilities, those applying for a construction permit after July 30, 1997, are now required to obtain a construction permit to build a landfill and an operating permit to begin receiving waste. For owners of new facilities, a closure FAI is due prior to obtaining the initial construction permit, and a post-closure FAI is due prior to obtaining the initial operating permit.

If the operations are phased, the initial closure FAI only needs to include the amount necessary to close the first phase of the landfill, while the initial post-closure FAI must include the separable post-closure costs for the first phase, plus the inseparable post-closure costs for the entire landfill. Separable costs are those which are common only to a particular phase, such as cover maintenance. Inseparable costs are those which are common to the entire landfill, such as annual inspections, gas monitoring, and groundwater monitoring. These inseparable activities will be required for the entire landfill for the duration of the post-closure period whether or not subsequent phases are developed. For subsequent phases of new facilities, both the closure FAI and separable post-closure FAIs are due when operation of the phase is requested.

Existing facilities

Owners of existing facilities must have a closure and post-closure FAI in place for any area of the landfill in which waste was placed after Jan. 1, 1987. For newly developed phases of existing facilities, as with new facilities, both the closure FAI and separable post-closure FAIs are due when operation of the phase is requested.

Worksheet

In order to determine the amount of funding required for financial assurance, it is necessary to do a cost estimate. The purpose of the closure cost estimate is to determine the funding required for the department to complete landfill closure. The purpose of the post-closure cost estimate is to determine the funding required for the department to maintain and monitor the facility for the duration of the post-closure period.

To simplify the cost estimation process, the department has developed the attached worksheet to be used in calculating the amount of financial assurance required for closure and post-closure. To understand the need for a simplified worksheet, you must first understand the scenario under which the department will be required to perform closure and post-closure activities. In this situation, there will either be no responsible party, or the responsible party will be unwilling or unable to perform closure or post-closure activities. There is no other reason for the department to assume these responsibilities. In this scenario, it is quite likely that the facility has been poorly managed, either operationally, financially, or both.

In a premature closure scenario, it is unlikely that the landfill will resemble what was depicted in the approved final contour drawings. Some areas of the landfill may be at the permitted final elevation while others may be significantly lower, or higher if the landfill was poorly managed. It is likely that extensive regrading will be required for cover construction; surface water may have to be routed differently than indicated in the approved design and some portions of the gas system may be installed while others are not. The department will likely hire a consultant to determine the most cost-effective method of closure. No one can anticipate all possible scenarios, nor is the FAI intended to provide funds for all possible scenarios. It is also difficult to accurately estimate the costs for complicated systems such as landfill gas collection systems even under ideal circumstances, much less during a premature closure scenario.

For this reason, the cost estimates are not intended to be extremely detailed or complicated. They are intended as a simple method of providing a reasonable amount of money to allow the department to evaluate the condition of the landfill and close it in accordance with the minimum requirements of the regulations and any special requirements imposed by the design engineer. The most important thing is that estimates be reasonably accurate and include costs for all major aspects of landfill closure and post-closure.

The attached worksheet must be completed in order to determine the closure and post-closure costs. Any critical feature(s) included in the design for which there is no line item on the worksheet must be accounted for as well. For these features, the department will allow the use of third party quotes or professional judgement on the part of the design engineer in preparing cost estimates. These estimates should be attached to the worksheet.

Please note that this worksheet only applies to facilities with Subtitle D (composite) caps or standard soil caps (two feet of compacted clay overlain with one foot of vegetative soil). Some demolition landfills, utility waste landfills, and special waste landfills are designed with other types

of caps. The department will work with the owners of these facilities on a case by case basis to determine the amount of financial assurance required, using the principles and unit costs developed in this technical bulletin.

Due to variations in design, more than one worksheet may be necessary for your facility. For example, some older landfills have both Subtitle D areas and areas with soil caps. Some portions of the landfill may be required to have an active gas extraction system while others are not. In some cases, for example where a Subtitle D permit has superceded a previous permit, one worksheet can be completed to account for all areas within a permitted landfill. However, we suggest that you complete a separate worksheet for each distinct area. The worksheet is simple enough that this should not be difficult. In no case should areas with different permit numbers be combined on the same worksheet. The text of the plan should address each distinct area and explain the variations in design from one area to the next.

For a facility where all areas or phases are designed the same, such as a complete Subtitle D facility, as subsequent phases are opened you should submit a new worksheet that accounts for all phases of the landfill. For example, if you are submitting a request to open the fifth of ten phases, you should replace previously submitted worksheets with a new one that accounts for the total acreage for phases one through five.

The worksheet is based on unit closure costs for the following standardized aspects of design:

- Compacted clay cap
- Gas collection or venting system
- 40 mil low density polyethylene membrane
- Geocomposite drainage net, if applicable
- Vegetative soil
- Surface water controls
- Vegetation
- Borrow area reclamation
- Professional services

Owners of Subtitle D facilities must provide an FAI for either an active gas extraction system or a passive venting system. You must provide an FAI for an active system only if you are:

1. required to install the system by the department to control off-site gas migration,
2. required to install the system under the Federal New Source Performance Standards (NSPS), or,
3. required to install the system by some other regulatory agency.

If you own a Subtitle D facility and do not meet any of these conditions, you are only required to provide an FAI for a passive venting system. Owners of non-Subtitle D facilities (with soil caps) are not required to provide an FAI for a gas control system at all unless they meet at least one of the above conditions.

For simplicity, the worksheet costs are the same for active extraction wells and passive vents. Costs for wells or vents must be included in the cost estimate for the phase in which they will be physically located. However, costs for other components such as connecting piping, blowers, and flares, if required, only need to be included in the cost estimate at the point they are determined to be necessary by the design engineer. Again, this will depend entirely on the phase development and closure sequence discussed previously.

For example, assume that your landfill is large enough that you will eventually be required to install a gas extraction system under NSPS. The design engineer determines that the emissions will exceed the threshold limit when the fifth of ten phases are in place. In other words, if the landfill closes prematurely after only four phases are in place, the facility will be below the threshold limit and only a passive venting system will be required. The costs for the gas vents for each of the first four phases must be included in the FAI cost estimates for those phases because they will be required regardless of whether the fifth phase is ever constructed. You must at least vent Subtitle D landfills. You must use Form B, the Worksheet for Passive Gas System, through the first four phases. However, when you request to operate the fifth phase, since this will cause you to reach the threshold limit, you must now convert the passive vents to active extraction wells, install connecting piping, and the blower/flare station. To calculate your closure cost for this system, you must complete Form A, the Worksheet for Active Gas Systems.

The worksheet is based on unit post-closure costs for the following standardized maintenance and monitoring activities:

- Site inspections
- Erosion repair and revegetation of final cap
- Groundwater sampling and analysis
- Gas monitoring
- Leachate disposal
- Groundwater monitoring system maintenance and repair
- Gas monitoring system maintenance and repair
- Gas control system maintenance and repair (if applicable)
- Leachate management system maintenance and repair
- Professional services

Owners of facilities that voluntarily design and install an active gas system will be required to provide post-closure maintenance costs for the system once it is constructed. This is simply because, once the system has been built, the department will have to maintain it.

Worksheet unit costs

In the event the department is required to close a landfill, labor rates for the project will be in accordance with the prevailing wage rates in the county in which the landfill is located. Therefore, the unit costs in the worksheet are based primarily on R.S. Means publications because they reflect average national wage rates. A detailed analysis of the unit costs is available upon request.

You will note that the costs vary significantly depending on the round trip haul distance from the borrow area, and whether or not the landfill owner has granted an easement to the department for use of the borrow soils for closure. The higher costs due to increased haul distance should be apparent. Costs are also tied to the easement because, if the department is required to complete closure of a landfill or perform cover maintenance during the post-closure period, the costs will be much higher if we have to purchase the soil from an outside source. Therefore, unless you have executed an easement with the department that allows the use of borrow soil for closure and post-closure, we must make an assumption as to the availability of borrow soil. This assumption is that we will be able to locate and purchase the required quantity of suitable soils within five miles of the site. Therefore, for the purposes of cost estimating, we will assume a round trip haul distance of 10 miles.

Updating the cost estimate and FAI

One of the advantages of the simplified worksheet is that it minimizes the changes required to the cost estimate and the FAI. In order to understand this, you must understand the distinction between changes to the cost estimate and changes to the FAI.

The cost estimate is based on the major aspects of landfill design such as total acreage permitted for waste disposal (landfill footprint), the type of cover (subtitle D or non-subtitle D), the type of gas system (active or passive), and the number of groundwater monitoring wells. Once your cost estimate has been revised to match the figures in this technical bulletin, it must be updated only if some design aspect changes.

The FAI is a document ensuring that a reasonable amount of money is guaranteed to the department to complete closure and post-closure activities. It is based on the cost estimate. The amount of money must be updated annually for inflation, or if the cost estimate changes.

To illustrate this, we will use the following example:
Assume that, once your cost estimate is revised to match the figures in the technical bulletin, your closure cost estimate is $2 million and your post-closure cost estimate is $3 million. If you operate for twenty years and never modify any aspect of design, you will never need to change that cost estimate. You only need to increase the FAI annually for inflation, as outlined below. However, assume that at some point you are required by the department to install an active gas system to control a gas migration, or add two groundwater-monitoring wells. You must submit a new worksheet accounting for the increased closure or post-closure cost for the modification. Once the modifications and new cost estimate are approved by the Solid Waste Management Program, you will be required at that time to update your FAI to match the new cost estimate. From that point on, the FAI must be increased annually for inflation, but no changes to the cost estimate will be necessary unless further design changes are approved.

It is important to note that using the worksheet to update a cost estimate will always result in an estimate in year 2000 dollars. This figure must then be updated for inflation to the current year.

Annual adjustments for inflation

Annual adjustments for inflation are determined by increasing the original dollar value using a multiplier. The multiplier is the latest percent change in the Implicit Price Deflator (IPD) for the Gross Domestic Product as determined by the U.S. Department of Commerce. The IPDs change every quarter depending on the current rate of inflation. You must always use the most recent IPD when updating a cost estimate or FAI. The most recent IPD can be obtained from the Solid Waste Management Program.

Forms Available Online

Closure and Post-Closure Cost Worksheet
http://www.dnr.mo.gov/oac/forms/780-1882.pdf
Form A - Active Gas System Worksheet
http://www.dnr.mo.gov/oac/forms/780-1881.pdf
Form B - Passive Gas System Worksheet
http://www.dnr.mo.gov/oac/forms/780-1880.pdf
Table 1 - Cover Systems Construction and Repair Costs
http://www.dnr.mo.gov/oac/forms/780-1879.pdf

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